

Description

Mobile radio system, and a mobile station

5 The present invention relates to a mobile radio system and to a mobile station which are suitable for carrying out transmission/reception operation in the duplex and semiduplex mode.

10 Previous mobile radio systems operating in the duplex mode operate at specific uplink and downlink frequencies, with each mobile station needing to have a direct link to a base station. In this case, signals between two mobile stations are not transmitted directly from one mobile station to the other, but via 15 one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile 20 station A can set up a link to the base station, the mobile station B cannot, since it is out of range of the base station (for example in a valley or on a bridge). No link can therefore be set up between the mobile stations A and B even if, for example, there is 25 a visual link between them. Since it has so far not been possible to overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and constructed, in which 30 communication takes place directly between two mobile radios, without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

35 The object of the present invention is thus to provide a mobile radio system and a mobile station which, in addition

to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

5 The object is achieved by the features of the independent claims.

Accordingly, a mobile radio system having a number of mobile stations is provided, in which the mobile stations have means for carrying out transmission/reception operation in the duplex mode and 10 in the semiduplex mode. The mobile stations are thus suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present 15 invention, a first mobile station contains means for carrying out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode, thus allowing simultaneous communication to be set up from the first 20 mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, means are provided for carrying 25 out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the 30 duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode can thus be superimposed (interleaved) in such a manner that the transmission/reception operation is carried out virtually 35 simultaneously in the duplex and semiduplex mode without any mutual influence.

If the first mobile station is provided with means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, in such a 5 manner that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa, communication can be set up between the base station and the second mobile station with the interposition of the first mobile 10 station as a repeater, even when there is no direct link from the second mobile station to the base station.

In accordance with another embodiment, the first mobile station contains means for carrying out 15 transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode, thus allowing simultaneous communication to be set up directly from the first mobile station to the second and third mobile station 20 in the semiduplex mode without any link to a base station.

If the first mobile station is provided with means for carrying out transmission/reception operation with the second and the third mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the one 25 mobile station to the third mobile station and vice versa, communication can be set up between the second and third mobile station with the interposition of the one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

If a number of mobile stations are coupled to one another, then a communication chain or 35 communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

5 In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station is equipped with means for manually or automatically switching on and off the transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater can thus be activated or deactivated.

10 10 The present invention will be explained in the following description with reference to the drawing.

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

15 15 Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands to be used; and

20 20 Figure 6 shows an illustration of timeslots to be used.

Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally using a timeslot method in which the transmitter and receiver are active at different times. The transmitter 25 in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, 30 such a band may lie in another frequency band or, as shown in figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a) allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ in the nature of the transmission, and in length. The reference symbol RX denotes reception and TX transmission of signals in the duplex band. Overall, this means that it is possible to work virtually simultaneously in both bands (see Figure 6c).

As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is thus possible for the mobile station A to communicate simultaneously with the base station and the mobile station B.

25 Figure 2 shows a situation in which the mobile
station A is being used as a repeater. As in the
situation shown in Figure 1, there is a direct link
between the base station and the mobile station A,
while there is no direct link between the base station
30 and the mobile station B. However, the mobile station A
converts the semiduplex mode information transmission
to duplex mode information transmission, and vice
versa, so that communication is set up between the base
station and the mobile station B. This means that data
35 are transmitted using the semiduplex mode from the
mobile station B to the mobile station A, are processed
in the mobile station A and are passed on using the
duplex mode to the base station and, in the opposite

direction, are transmitted from the base station to the mobile station A using the duplex mode, are

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processed in the mobile station A, and are passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible for the mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa).
10 Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain comprising
15 a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or two further stations or else operation as a repeater. If required, the control device may automatically select operation as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

25 The advantage of the mobile radio system in the present invention, in which mobile stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A 30 further advantage is that a mobile station can likewise be operated from an aircraft. In a conventional mobile radio system, operation of a mobile station from an aircraft while flying is normally impossible since the mobile station cannot set up communication with a 35 specific base station from the large number of accessible base stations. By using

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mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.

Furthermore, the mobile radio system in the present invention can be designed to be self-organizing. By using new transmission methods such as JD-CMDA, it can provide very high transmission capacities. Such a combined system makes it possible to integrate virtually all the radio and mobile requirements which arise and operate with limited range and, possibly, with high traffic densities: wireless LAN, DSSR digital short range radio, LPD low power devices, TETRA trunked mobile radio and BOS, railroad radio, cordless telephones, mobile telephones, aviation radio, maritime radio, emergency paging systems and cordless buses (for control functions).

In one design variant of the invention, the term duplex mode means a frequency division duplex (FDD) mode, and the term semiduplex mode means a time division duplex (TDD) mode. In this case, different frequency bands can be provided for the uplink (mobile station to base station) for FDD (Frequency Division Duplex) systems, such as the GSM system or UTRA (Universial Mobile Telephony System) Terrestrial Radio Access) FDD mode than for the downlink (base station to mobile station), and different time periods can be provided for the uplink and downlink for TDD (Time Division Duplex) systems such as DECT (Digital Enhanced Cordless Telecommunications) system or the UTA (UMTS (Universial Mobile Telephony System) Terrestrial Radio Access) TDD mode.